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THE CORNELL REPORT

PRODUCTIVITY IN GROCERY DISTRIBUTION CENTERS 1981

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INTRODUCTION

The 1981 Cornell Report on Productivity in Grocery Distribution Centers represents a departure from the traditional reporting of only physical labor productivity and warehouse characteristics. This year's report, while retaining some physical productivity measures, is based primarily on annual cost and operating data submitted by 46 warehouses located in the U.S. and Canada. Its expanded focus addresses the degree of efficiency achieved not only in employing labor, but also inventory, buildings, equipment, management and other costly inputs to the warehousing process. The report is intended primarily for distribution executives and managers who wish to 1) evaluate the total cost efficiency of their operations by comparison to the performance of similar warehouses and 2) identify areas of warehouse operations and management which may be contributing to sub-optimal performance.

REVISIONS FOR 1981

This report contains 16 data tables including information on unit costs and cost efficiency, physical labor productivity, operating practices, warehouse management, work force characteristics and labor relations. As in recent years, individual participating distribution centers are able to identify themselves by the confidential code number found at the left margin of each table.

Ranking

The data in all 16 tables of the report are ranked in ascending order of potential savings. That is, warehouses with less possible cost savings (i.e., are more cost efficient) are listed toward the top while those with

greater savings possibilities follow in order of increasing potential. The ranking based on potential savings is a change from previous years and represents an improvement over ranking on cost per unit (i.e., cost per case or ton) or physical units per man hour.

Neither total unit cost including costs of labor, inventory, occupancy, equipment, supervision and miscellaneous factors nor physical units handled per manhour provides a complete basis for efficiency comparisons among distribution centers. The latter criterion, which ignores the other economic inputs besides labor, served as a valid basis for comparison when the costs of those factors were negligible compared to wages. Today's economy with its statospheric interest rates and inflated energy costs along with new technology has increased the relative importance of inventory, equipment and energy costs to the point where they no longer can be ignored.

Average cost per unit, although an important factor in bottom line performance, is not by itself very useful when comparing one distribution center to another for the purpose of analyzing productivity. This is a result of the fact that cost per case depends to a great extent on the prices which each center must pay for labor, warehouse space, etc. - factors over which the distribution director often has no control. For example, comparing the per unit cost of an operation which pays ten dollars per hour for labor with one paying five dollars probably provides little insight into which is more efficient. Consequently, a more useful measure of performance is one based not on what costs are, but on how much they might be reduced if warehousing could be made more efficient.

The potential savings percent column found in Table 1 is the basis for ranking the 39 comparable participants in this report. These savings percentages were determined by comparing each distribution center's total annual

cost to the cost of other operations. Statistical procedures were used to adjust each warehouse to a standard base cost insuring comparability with similar operations in terms of size, wage rate, etc. In particular, each center was compared to others which:

1. shipped an equivalent annual physical case volume,
2. paid about the same wage and benefits,
3. incurred a similar opportunity cost for holding inventory,
4. spent an equivalent amount for warehouse space occupied, either in the form of rent or depreciation charges on owned buildings,
5. used and incurred the cost of equivalent equipment in terms of quantity, age and type.

Comparable and noncomparable operations

Distribution centers handling dry grocery items exclusively or predominately in combination with other commodities are considered to be comparable and eligible for ranking in this report. The volume shipped from centers handling mixed commodities was adjusted to equivalent case units as necesnary to insure comparibility across the sample. Case units were used for measuring shipment volume to maintain continuity with previous reports and because tonnage figures continue to be unavailable or inaccurate.

Noncomparable operations are those which specialize in product classes other than dry grocery (e.g., perishable, nonfood). They are included at the bottom of each table but unfortunately cannot be ranked by cost efficiency due to an inadequate sample size.

Appropriate price indices were used to adjust costs and prices for all firms to a December 1981 basis in order to insure equivalent cost comparisons in spite of various fiscal year-ending dates.

Summary statistics

The mean (average), minimum and maximum value of numeric columns are printed at the bottom of the comparable observations in each table. These statistics provide a basis for comparison of individual operations relative to the group and to summary statistics from previous reports.

Table highlights

Opposite each table in the report the reader will find a brief description of the data presented and preliminary observations as to which factor(s) appears to influence cost efficiency.

Data errors

Although the data received from participants were carefully screened, it is possible that errors may be reflected in the reported figures. Comments regarding errors or the contents of this report are appreciated and should be directed to the authors.

FUTURE RESEARCH

The growing complexity of food distribution makes it unlikely that any single variable or even a small group of variables can be isolated as a major determinent of efficiency. Instead the complex interrelationships among the factors influencing productivity must be analyzed in a clear understandable framework. Such an analysis of this year's data will be reported to the participants and the industry in a sequel to the 1981 report forthcoming later this year.

Table 1 contains information on unit costs, potential cost savings and the physical productivity of labor identified by the confidential ID code in the first column.

Cost per case shipped is computed by dividing the sum of total annual costs of labor, inventory, occupancy, equipment, warehouse supervision, support labor and miscellaneous expenses by the number of case units shipped during a one-year period.

The potential savings percent was determined by comparing each center's total cost to operations shipping equivalent volume and incurring similar wages, inventory costs, rent and equipment charges. The comparable warehouses listed in this table and those which follow are ranked according to increasing potential savings percent (i.e., decreasing cost efficiency).

As expected, cases shipped per manhour of direct labor corresponds closely to potential savings. Considering the large portion of total cost attributable to wages, one would expect those making better use of labor to be more cost efficient.

Table 1. Unit Costs, Potential Savings and Labor Productivity

ID[1/]	Cost per Case Shipped (¢/case)	Potential Savings (%)	Potential Savings (¢/case)	Minimum Possible Unit Cost (¢/case)	Cases Shipped/ Direct Labor Hr.
08	40.3	5.0	2.0	40.3	102
35	45.3	7.8	3.5	41.8	82
61	34.0	10.2	3.4	30.5	114
03	43.7	10.3	4.5	39.2	68
24	29.8	12.2	3.6	26.1	77
58	49.7	16.6	8.2	41.4	69
15	55.9	17.9	10.0	45.9	82
09	45.6	19.0	8.6	37.0	73
62	40.4	19.8	8.0	32.4	71
49	38.8	21.7	8.4	30.4	87
12	47.6	24.2	11.5	36.1	62
13	42.8	24.9	10.6	32.1	69
10	60.3	25.9	15.6	44.6	61
21	44.7	26.2	11.8	33.0	69
28	67.6	27.3	18.4	49.1	63
56	61.2	28.9	17.6	43.5	51
20	66.8	29.6	19.8	47.0	52
02	47.3	29.7	14.0	33.2	57
18	53.0	30.4	16.0	36.8	56
37	56.2	30.4	17.1	39.1	55
16	63.8	32.1	20.5	43.4	61
42	38.8	34.1	13.2	25.6	65
51	77.1	34.4	26.5	50.6	52
33	51.6	34.4	17.8	33.8	41
22	50.2	34.7	17.4	32.8	51
50	81.2	35.7	29.0	52.2	49
48	50.4	36.4	18.4	32.0	47
54	59.0	36.6	21.6	37.4	46
23	59.8	37.4	22.4	37.4	61
39	71.6	37.6	26.8	44.6	51
41	45.2	37.6	17.0	28.2	56
63	84.0	39.5	33.2	50.8	41
59	63.0	39.6	25.0	38.0	33
25	63.2	40.6	25.6	37.5	48
40	47.5	42.8	20.4	27.2	56
60	73.2	45.0	33.0	40.2	40
55	71.2	45.4	32.3	38.9	33
29	61.4	47.6	29.2	32.2	41
57	92.3	51.0	47.1	45.2	25
Mean	55.8	29.8	17.7		59
Min.	29.8	5.0	2.0		25
Max.	92.3	51.0	47.1		114
		Noncomparable Operations			
43	75.7				52
44	30.0				98
45	12.2				180
46	28.6				82
47	38.5				71
52	138.1				32
53	77.7				51

1/ Ranked in order of increasing potential savings.

Table 2 contains a breakdown of cost per case into seven accounting categories: direct labor, inventory, occupancy, equipment, warehouse supervision, support labor and miscellaneous which includes second level managers, utilities and supplies. A glance at the mean (average) of the comparable operations shows the relative importance of the unit cost of labor (mean = 25.8 cents per case) and inventory (mean = 12.9 cents per case).

The sum of unit accounting category costs for an individual distribution center may not be exactly equal to its total cost per case in Table 1 due to rounding error. The comparable operations are again sorted in order of ascending potential cost savings from Table 1.

Table 2. Unit Cost by Accounting Category
(¢/case shipped)

ID 1/	Direct Labor	Inventory	Occupancy	Equipment	Warehouse Supervisors	Support Labor	Other
08	17.4	11.2	3.2	1.0	2.2	2.4	2.6
35	18.8	12.5	3.0	3.8	3.8	0.2	3.0
61	13.2	7.0	6.8	0.6	1.8	2.7	1.8
03	15.2	12.0	2.9	1.3	2.9	5.4	4.0
24	13.3	8.4	0.8	1.8	0.8	1.8	2.5
58	27.8	8.6	2.2	0.7	2.4	5.7	2.1
15	23.5	13.0	5.2	2.4	2.3	6.2	3.3
09	9.7	14.2	9.6	1.2	2.0	3.0	6.7
62	16.4	10.6	5.0	1.4	4.0	1.8	1.2
49	18.4	7.9	3.6	2.3	0.9	3.8	1.8
12	24.1	8.0	3.1	3.0	3.0	2.2	4.0
13	18.3	13.8	2.2	0.3	1.2	2.4	4.4
10	35.8	6.5	1.6	1.0	3.4	7.4	4.8
21	17.0	12.6	1.6	3.0	3.2	4.1	3.1
28	26.6	21.0	3.0	3.2	2.8	6.8	4.2
56	29.8	11.8	3.4	0.9	2.8	7.9	4.4
20	34.0	16.1	3.6	1.2	3.2	5.6	2.9
02	22.0	12.9	2.6	0.2	1.3	5.6	2.4
18	17.6	15.9	5.4	1.8	2.8	6.0	3.4
37	24.1	11.7	4.8	2.4	2.4	5.4	5.2
16	31.0	18.4	6.8	0.9	2.2	1.0	3.5
42	16.0	9.1	3.8	1.6	2.1	3.2	2.8
51	38.4	14.8	3.6	1.2	4.3	11.8	2.8
33	16.6	19.8	3.8	3.2	2.2	2.1	3.8
22	23.8	12.6	1.8	1.0	2.6	5.2	3.2
50	41.0	14.8	2.4	1.6	4.2	12.5	4.5
48	23.2	11.9	4.1	2.0	3.1	1.3	4.6
54	30.8	11.3	3.4	0.8	3.6	5.7	3.1
23	18.8	19.0	7.0	3.2	2.8	4.5	4.3
39	35.0	15.0	4.0	1.4	2.7	9.1	4.2
41	16.4	10.8	6.0	1.2	2.9	3.4	4.4
63	54.4	10.4	1.2	1.8	3.1	11.2	1.6
59	21.2	15.4	3.8	9.6	2.4	6.4	4.0
25	26.4	14.2	4.1	7.4	2.4	5.4	3.2
40	28.8	8.8	0.7	2.3	0.6	3.0	3.0
60	41.4	13.7	6.2	1.7	3.8	2.2	4.1
55	42.8	11.6	0.8	1.0	3.6	7.8	3.3
29	31.6	15.8	3.3	5.2	2.5	0.4	2.4
57	48.0	19.4	2.4	5.6	5.0	4.8	6.8
Mean	25.8	12.9	3.6	2.2	2.7	4.8	3.6
Min.	8.8	6.5	0.7	0.2	0.6	0.2	1.1
Max.	54.4	21.0	9.6	10.0	5.0	12.5	6.8
			Noncomparable Operations				
43	20.2	8.4	16.7	13.0	1.9	4.1	11.4
44	9.6	3.0	5.5	3.8	1.6	2.0	2.4
45	5.4	2.6	0.9	0.6	0.6	1.1	0.8
46	12.5	2.2	3.5	3.2	1.7	2.6	2.9
47	14.4	6.5	5.5	3.6	1.9	3.0	3.6
52	64.8	23.8	6.6	3.1	5.6	15.1	18.9
53	40.2	7.2	1.8	2.8	4.3	17.1	4.1

1/ Ranked in order of increasing potential savings.

Percents of total warehousing cost attributable to each of seven accounting categories are presented in Table 3. Again, as in Table 2, labor and inventory costs are found to be the most important, this time in terms of their shares of total cost. The sum of accounting category cost shares for an individual distribution center may not be exactly equal to 100 percent due to rounding error.

Comparable operations appear in order of increasing potential cost savings from Table 1.

Table 3. Percent of Total Cost by Accounting Category

ID 1/	Direct Labor	Inventory	Occupancy	Equipment	Warehouse Supervisors	Support Labor	Other
08	43.3	27.9	7.8	2.4	5.6	6.2	6.6
35	41.6	27.6	6.5	8.4	8.4	0.4	6.8
61	38.8	20.4	19.8	1.9	5.5	8.0	5.4
03	34.6	27.4	6.6	3.0	6.6	12.4	9.2
24	45.0	28.5	2.6	6.4	2.6	6.3	8.4
58	56.0	17.4	4.4	1.4	4.8	11.5	4.3
15	42.0	23.2	9.2	4.2	4.2	11.0	6.0
09	19.2	31.2	21.2	2.5	4.4	6.6	14.7
62	40.5	26.2	12.3	3.6	9.8	4.6	2.9
49	47.3	20.4	9.4	6.4	2.4	9.7	4.7
12	50.6	16.8	6.5	6.4	6.4	4.8	8.4
13	42.8	32.3	5.0	0.8	3.0	5.5	10.4
10	59.4	10.8	2.6	1.6	5.6	12.2	7.8
21	37.9	28.1	3.6	6.8	7.1	9.2	7.1
28	39.4	31.0	4.4	4.6	4.1	10.0	6.2
56	48.8	19.3	5.6	1.4	4.6	13.0	7.2
20	51.0	24.2	5.3	1.8	4.8	8.4	4.4
02	46.5	27.2	5.6	0.6	2.8	12.0	5.1
18	33.1	30.0	10.4	3.5	5.2	11.4	6.3
37	42.8	20.8	8.6	4.4	4.3	9.7	9.2
16	48.5	28.8	10.6	1.4	3.4	1.6	5.5
42	41.2	23.4	9.6	4.4	5.5	8.4	7.3
51	49.8	19.2	4.8	1.6	5.6	15.3	3.6
33	32.2	38.3	7.4	6.1	4.4	4.0	7.4
22	47.4	25.0	3.6	2.0	5.1	10.4	6.4
50	50.4	18.2	3.0	2.0	5.2	15.4	5.6
48	46.1	23.6	8.2	3.8	6.2	2.6	9.3
54	52.2	19.2	5.8	1.4	6.2	9.7	5.3
23	31.4	31.7	11.8	5.4	4.7	7.6	7.2
39	48.9	21.0	5.6	1.9	3.8	12.8	5.8
41	36.3	24.0	13.2	2.6	6.4	7.4	9.9
63	64.8	12.4	1.5	2.2	3.7	13.3	2.0
59	33.6	24.6	6.0	15.2	3.9	10.3	6.3
25	41.8	22.4	6.6	11.8	3.7	8.6	5.1
40	60.7	18.6	1.6	4.9	1.4	6.3	6.4
60	56.5	18.7	8.6	2.3	5.2	3.0	5.6
55	60.2	16.2	1.2	1.4	5.1	11.0	4.8
29	51.5	25.7	5.4	8.4	4.1	0.8	4.0
57	52.0	21.0	2.6	6.2	5.4	5.2	7.4
Mean	45.3	23.6	7.0	4.0	4.9	8.3	6.6
Min.	19.2	10.8	1.2	0.6	1.4	0.4	2.0
Max.	64.8	38.3	21.2	15.2	9.8	15.4	14.7
			Noncomparable Operations				
43	26.6	11.1	22.0	17.2	2.6	4.1	11.4
44	34.4	10.6	19.8	13.8	5.7	2.0	2.4
45	44.8	21.6	7.4	5.2	5.1	1.1	0.8
46	43.7	7.9	12.1	11.2	5.9	2.6	2.9
47	37.5	16.9	14.3	9.3	5.0	3.0	3.6
52	47.0	17.3	4.8	2.3	4.0	15.1	18.9
53	51.8	9.3	2.4	3.7	5.5	17.1	4.1

1/ Ranked in order of increasing potential savings.

Table 4 is a summary of the characteristics of participating warehouses including ownership, product mix, building size, line items and annual equivalent cases shipped.

In order to facilitate comparison in the presence of different product mixes (e.g., grocery only vs. grocery and non foods vs. grocery and perishables) the annual output (volume shipped) of each distribution center has been converted to equivalent case units. Therefore, participants may find that their reported number of annual cases shipped in Table 4 does not exactly match total shipments reported in the questionnaire.

Comparable operations appear in order of increasing potential cost savings from Table 1.

Table 4. General Characteristics

ID 1/	Warehouse Owner 2/	Product Mix 3/	Floor Space (1000 sq. ft.)	Height	Items Carried	Annual Cases Shipped (1000 cs.)
08	R	GFDRMPO	83.9	14	6200	5267.6
35	W	GFDRMPO	400.0	22	17150	18646.7
61	R	G	492.2	24	4785	26647.3
03	R	GDR	170.1	19	4791	6501.0
24	R	GDRMP	187.0	18	8360	11043.8
58	R	GFDR	200.0	22	8678	18903.8
15	R	GFR	287.2	22	5241	14514.3
09	W	GFDRM	81.5	26	5354	2769.2
62	R	G	254.8	23	3945	10938.4
49	R	G	577.0	18	3398	38906.1
12	R	G	200.0	27	3850	11241.5
13	R	GR	128.0	16	5558	5109.4
10	R	GDMP	428.7	17	8726	23890.4
21	R	GR	174.0	22	7450	4708.0
28	R	GR	342.4	26	10000	14067.7
56	R	GP	470.4	18	8685	13304.9
20	R	G	251.2	16	4957	9470.4
02	R	GR	100.4	17	6659	6045.5
18	R	GR	240.2	21	5684	9821.4
37	R	G	350.0	20	4500	16016.9
16	R	G	261.2	20	5400	10402.6
42	R	GR	794.6	21	6209	24861.1
51	R	G	381.4	24	4900	15666.7
33	W	GFDRMP	80.7	19	9496	4762.2
22	R	GR	117.5	17	6300	4217.0
50	R	G	381.9	18	4800	15666.7
48	W	GFDMPO	171.2	18	12920	7113.4
54	R	GP	271.6	16	7500	11887.5
23	R	GFDMP	342.7	17	9200	10989.8
39	R	GFDRMP	215.0	15	5229	6627.6
41	R	G	35.5	21	460	2900.9
63	C	G	312.0	22	8200	19493.0
59	R	GFDRMPO	263.7	24	30400	17591.2
25	R	G	677.0	22	6166	18823.9
40	R	GRO	525.0	18	16820	50199.9
60	W	GDR	345.6	26	6500	13837.0
55	R	GP	265.0	15	7250	12167.3
29	R	GDR	169.0	25	5270	6352.4
57	C	GFDRM	300.0	19	7985	7477.6
Mean			291.8	20	7563	13432.1
Min.			80.7	14	460	2769.2
Max.			794.6	27	30400	50199.9
		Noncomparable Operations				
43	R	F	60.0	30	660	4823.2
44	R	DMO	48.0	25	675	11706.8
45	R	R	253.5	22	10066	50177.7
46	R	P	31.2	24	468	5527.1
47	R	GFDRMPO	933.8	22	8012	46918.2
52	R	F	60.0	20	682	1931.4
53	R	P	507.1	8	2700	18610.8

1/ Ranked in order of increasing potential savings.

2/ R - Retailer
W - Wholesaler
C - Retailer Owned Cooperative

3/ G = Grocery D = Dairy M = Meat O = Other
F = Frozen R = Repack P = Produce

Several aspects of receiving operations are summarized in Table 5: 1) hours of operation, 2) weekly workload balance, 3) monthly workload balance and 4) unloading procedures.

Capacity utilization, scheduling policy and local truck and rail service are reflected in the number of hours per day devoted to receiving activities.

The portion of weekly receipts processed on each day of the week and on weekends is reported in the weekly balance section. As would be expected, a more even distribution of inbound volume over the week is found in the more cost efficient operations. This balance, which is obtained through effective coordination and scheduling, facilitates better utilization of resources (e.g., labor, dock facilities, storing equipment) resulting in cost efficiencies.

Week-to-week receiving balance, summarized under monthly balance in Table 5, appears to be less variable than day-to-day fluctuation and thus is not as important to efficiency as daily balance.

Percent of trucks unloaded by warehouse employees reflects differences in company policy, carrier relations and union understandings. A clear pattern relating the amount of unloading done by the warehouse and cost efficiency is not apparent.

Comparable operations appear in order of increasing potential cost savings from Table 1.

Table 5. Receiving Operations

ID 1/	Hours per Day	Weekly Balance (%)						Monthly Balance (%)				% of Trucks Unloaded by Warehouse
		M	TU	W	TH	F	WE 2/	1st wk.	2nd wk.	3rd wk.	4th wk.	
08	8	20	20	20	20	20		25	25	25	25	10
35	8	20	18	15	18	21	8	22	25	25	28	0
61	18	30	30	15	15	10		25	25	25	25	70
03	8	23	19	19	21	18		24	22	27	27	100
24	8	11	23	20	24	22		27	24	25	24	11
58	24											100
15	10	20	20	23	20	17		20	25	25	30	97
09	8	20	21	21	20	18		25	24	27	24	5
62	8	24	22	16	18	20		25	25	25	25	0
49	16	20	20	20	20	20		25	25	25	25	100
12	8	19	19	19	22	21		22	23	27	28	100
13	8	22	22	20	16	20		26	21	22	31	5
10	16											NA
21	8	21	15	26	19	19		22	29	28	21	0
28	16	18	24	23	20	15		24	22	26	28	100
56	8	20	20	20	20	20						100
20	16	19	20	21	19	21		25	21	26	28	100
02	NA	15	15	30	25	15		25	30	25	20	100
18	12	19	20	20	20	20	1	26	24	24	26	100
37	8	21	22	21	19	18		25	25	25	25	0
16	12	23	22	21	17	17		25	20	25	30	100
42	20											0
51	16	25	22	13	18	22						0
33	8	35	25	15	15	10		25	25	25	25	20
22	8	17	23	18	17	25		26	22	25	27	100
50	16	25	22	13	18	22						0
48	8	13	21	21	20	25		25	25	25	25	NA
54	10	15	16	23	23	23						100
23	7	24	18	21	17	16	4	26	24	22	28	6
39	9	25	20	20	20	15		25	25	25	25	95
41	8											0
63	24	18	18	21	20	21		19	23	28	30	5
59	NA	19	21	20	18	22		29	27	21	23	15
25	24	18	16	22	17	19	8	30	18	20	32	2
40	24	25	15	15	15	30		25	25	25	25	80
60	8	22	21	21	18	18		25	25	25	25	90
55	16	24	18	17	19	22						100
29	8	25	20	20	20	15		20	25	25	30	100
57	16	15	20	24	25	16		29	26	24	21	100
Mean	12											54
Min.	7											0
Max.	24											100
		Noncomparable Operations										
43	8											100
44	10											70
45	12											95
46	8											100
47	20											92
52	8											100
53	24											100

1/ Ranked in order of increasing potential savings.

2/ Week-end.

Table 6 contains data on storing operations including: 1) operating hours of storing activities, 2) pallet types, 3) dock to storage movement methods, 4) reserve stock location selection, 5) storage capacity utilization and 6) physical stock turnover.

Hours of operation typically are dependent upon receiving schedules and dock facilities and therefore usually cannot be changed independently. However, in the comparable warehouses single shift storing operations appear generally to be associated with greater cost efficiency.

Annual physical inventory turnover is the ratio of cases shipped during the fiscal year to the average physical inventory on hand.

Comparable operations appear in order of increasing potential cost savings from Table 1.

Table 6. Storing Operations

ID 1/	Hours per Day	% of Items on 48 x 40 Pallets	Movement Method 2/	Reserve Location 3/	% of Storage Utilization	Annual Physical Turnover
08	8	100	Dir	Conv	97	15.3
35	12	80	Mix	O/L	85	8.5
61	14	100	Dir	Conv	96	27.4
03	8	100	2S	Conv	65	9.5
24	8	32	Dir	Conv	80	20.8
58	24	95	2S	Conv	115	19.4
15	8	99	Dir	O/L	85	17.1
09	8	20	2S	Conv	68	6.0
62	8	100	2S	O/L	90	17.2
49	16	100	2S	Conv	92	23.0
12	8	100	2S	Conv	73	20.4
13	8	100	Dir	Conv	140	15.8
10	8	100	Dir	Conv	NA	27.5
21	8	100	2S	Conv	99	16.4
28	8	100	Mix	Conv	103	8.5
56	8	100	Dir	Conv	99	17.9
20	16	100	Dir	Conv	85	12.4
02	NA	100	Dir	Conv	76	20.0
18	12	93	Mix	Conv	101	17.1
37	8	100	Dir	Conv	94	17.0
16	12	100	2S	O/L	87	14.0
42	20	92	Mix	O/L	105	30.9
51	16	100	Dir	O/L	77	21.4
33	8	70	2S	Conv	100	7.8
22	8	100	2S	Conv	100	16.1
50	16	100	Dir	Conv	71	23.1
48	8	60	Dir	Conv	NA	20.0
54	10	100	Dir	Conv	82	26.3
23	8	99	2S	Conv	64	19.2
39	8	98	2S	Conv	93	23.0
41	16	100	Dir	O/L	88	19.3
63	24	20	Dir	Conv	111	14.1
59	NA	66	2S	Conv	100	9.0
25	24	90	Dir	O/L	89	11.9
40	24	100	Dir	Conv	83	17.4
60	NA	100	Dir	Conv	73	17.1
55	16	100	Dir	Conv	98	27.0
29	8	100	Dir	Conv	180	13.5
57	8	46	Dir	Conv	68	9.1
Mean	12	89			92	17.4
Min.	8	20			64	6.0
Max.	24	100			180	30.9
			Noncomparable Operations			
43	8	100	Dir	O/L	100	21.0
44	10	80	Dir	O/L	90	78.3
45	16	10	Mix	Mix	98	24.9
46	8	100	Dir	Mix	77	198.8
47	20	92	Mix	Mix	101	38.8
52	8	100	Dir	Dir	99	45.9
53	24	100	Dir	Dir	99	26.3

1/ Ranked in order of increasing potential savings.

2/ Dir - Direct: fork lift from dock to aisle and store
2S - Two stage: fork lift, pallet jack or train from dock - highlift stores in aisle
Mix - Both direct and two stage

3/ O/L - On line computer selected
Conv - Reserve location selected by operator
Mix - Both on line computer and operator selected

Order selection and its support activity, slot replenishment, are the topics of Table 7. Included is information on operating hours, replenishment methods, selection procedures and batch picking.

As was the case with storing (Table 6), single shift replenishment and selection operations generally appear to be associated with a greater degree of cost efficiency.

Replenishment procedures which rely on order selector demand for initiation may be the result of inadequate sized picking slots and/or poor product movement/slot size matching. Such methods cause waiting and thus idle labor time which translates into decreased cost efficiency.

Batch selection as an independent factor does not seem to be very important to productivity in this sample of comparable distribution centers.

Comparable operations appear in order of increasing potential cost savings from Table 1.

Table 7. Selection Slot Replenishment and Order Selection Operations

ID 1/	Hours per Day Replenishment	Replenishment Method 2/	Hours per Day Selection	% Conventional Selection	Batch Pick
08	8	O	8	100	
35	4	O	24	100	
61	14	CO	14	100	
03	8	O	8	100	
24	8	D	16	100	
58	24	OD	16	99	
15	11	C	8	100	
09	8	O	8	71	
62	8	D	8	80	
49	16	O	16	100	
12	16	O	16	NA	yes
13	8	O	8	100	
10	8	O	8	100	
21	8	OD	8	91	
28	8	O	16	98	
56	8	OD	8	30	
20	8	O	8	93	
02	NA	C	NA	100	
18	12	O	12	60	
37	8	O	8	100	
16	8	C	8	100	
42	16	C	16	98	yes
51	16	OD	16	100	
33	8	OD	16	56	
22	8	OD	8	100	
50	16	OD	16	100	
48	16	D	16	100	
54	16	OD	16	96	
23	8	O	8	100	
39	8	O	11	100	yes
41	16	C	16	100	
63	16	O	16	100	
59	NA	OD	NA	73	
25	16	C	16	100	
40	24	O	24	93	
60	NA	O	NA	30	yes
55	16	OD	16	29	
29	8	OD	8	100	yes
57	24	O	24	100	
Mean	12		13		
Min.	4		8		
Max.	24		24		
		Noncomparable Operations			
43	10	C	10	20	yes
44	13	C	10	50	
45	16	CO	16	25	
46	10	COL	10	65	yes
47	16	COL	16	74	yes
52	16	OD	16	0	
53	24	OD	24	100	

1/ Ranked in order of increasing potential savings.

2/ Computer - computer generated replenishment schedule
Operator - lift operator judgement
Demand - filled only as called by order selectors
List - handwritten list

Table 8 contains data on loading operating hours and the balance of daily and weekly shipments.

Single shift loading operations are found in many of the more cost efficient warehouses in this sample.

The portion of weekly volume shipped on each day of the week and on weekends is reported in the weekly balance section. Daily variability in shipping workloads appears to be greater than the daily fluctuations in receiving (Table 5, p. 14). At least part of this is due to the presence of weekend shipments by one-third of the participants. Such uneven distribution of shipments during the week often is a result of retail store replenishment demand which is derived from shopping patterns based on pay periods, promotional activity, etc. In light of this, there may be less opportunity to achieve uniformity of shipping volume than is the case with receiving. However, some degree of coordination, particularly in retail firms owning warehouses, should have a smoothing effect. Evidence of this can be seen by ignoring the operations which ship on weekends and noting that the remaining warehouses which achieve better daily shipping balance generally experience greater cost efficiency. The adverse impact of shipping imbalance on transportation cost, although not addressed in this report, certainly should be considered by management.

With a few exceptions, week-to-week shipping balance seems to be less variable than day-to-day fluctuation and therefore probably detracts less from productivity.

Comparable operations appear in order of increasing potential cost savings from Table 1.

Table 8. Shipping Operations

ID 1/	Hours per Day Loading	Weekly Balance (% of shipments)						Monthly Balance (%)			
		M	TU	W	TH	F	WE 2/	1st wk.	2nd wk.	3rd wk.	4th wk.
08	8	20	21	21	21	17		23	28	26	23
35	24	17	14	12	17	14	26	24	23	29	24
61	14	22	25	16	17	20		30	30	20	20
03	8	19	20	21	20	20		26	24	25	25
24	16	20	20	21	15	2	22	25	25	25	25
58	16										
15	8	22	21	16	19	21	1	26	25	24	25
09	8	23	21	13	15	0	28	25	25	25	25
62	8	23	24	16	19	18		26	23	26	25
49	16	19	21	20	19	21		25	25	25	25
12	16	21	20	21	18	20		25	25	25	25
13	8	20	19	18	20	2	21	23	22	22	23
10	8										
21	8	22	20	19	21	18		22	29	28	21
28	16	21	20	17	18	24		28	22	24	26
56	8	20	19	19	19	23					
20	8	22	21	19	18	20		26	25	24	25
02	NA	24	23	17	18	18		25	26	24	25
18	12	21	23	17	19	19	1	26	24	24	26
37	8	21	22	20	18	19		25	25	25	25
16	8	22	21	19	17	21		30	25	25	20
42	20										
51	16	21	21	19	21	18					
33	10	25	22	15	12	16	10	28	27	22	23
22	8	22	22	20	20	16		25	25	26	24
50	16	20	22	21	20	17					
48	16	25	21	21	18	15		25	25	25	25
54	16	19	27	18	17	16	3	25	25	25	25
23	8	20	19	20	16	17	8	27	26	25	22
39	11	28	25	12	25	10		35	25	20	20
41	16										
63	16	20	24	20	18	18		25	25	25	25
59	NA	20	16	15	14	18	17	24	24	27	25
25	24	12	18	15	14	15	26	25	24	24	27
40	24	18	16	16	15	25	10	25	24	26	25
60	NA	22	21	21	18	18		25	25	25	25
55	16	17	23	17	21	22					
29	8	21	22	15	28	14		25	23	23	29
57	24	20	25	17	20	16	2	25	27	24	24
Mean	13										
Min.	8										
Max.	24										
		Noncomparable Operations									
43	10										
44	13										
45	16										
46	10										
47	20										
52	16	24	24	27	0	25					
53	24	20	17	20	22	9	12				

1/ Ranked in order of increasing potential savings.

2/ Week-end.

Table 9 lists data on the makeup of loads shipped from each distribution center (i.e., percent of loads that contain one, two and more than two separate delivery orders) and the number and types of outlets served.

Comparable operations appear in order of increasing potential cost savings from Table 1.

Table 9. Load and Customer Profile

ID 1/	Single Order Loads (%)	2 Order Loads (%)	Multiple Order Loads (%)	Store Profile (number of stores served)			
				Supers	Smaller Grocers	Convenience	Other
08	48	34	18	35			
35	30	40	30	80	50		
61	88	12	0	142			
03	28	48	24	69			
24	10	27	63	96	13	8	
58	95	5	0	77			20
15	65	30	5	38			12
09	1	3	96	68	31	36	
62	68	32	0	94			
49	95	5	0	176			
12	98	1	1	58		1	
13	40	60	0	45			
10				108			
21	37	57	6	62			
28	83	14	3	66	23		
56				45			
20	75	25	0	93			
02	65	33	2	67			
18	44	54	2	102			
37	80	18	2	71			
16	63	33	4	88			
42	0	34	66	157			
51				90			
33	50	27	23	33	42	34	8
22	59	39	2	58			
50				91			
48	41	37	22	67			
54				65			
23	1	59	40	66			
39	10	80	10	50			
41				64			
63	37	20	43	279	467	393	26
59	63	13	24	53			13
25	86	14	1	100			
40	100	0	0	166			
60	86	14	0	170			
55				72			
29	95	5	0	41			
57	85	13	2	71	11	3	
				Noncomparable Operations			
43	5	15	20	156			
44	10	60	30	160			
45	12	72	16	160			
46	0	0	100	150			
47	3	34	63	160			
52				181			
53				181			

1/ Ranked in order of increasing potential savings.

Warehouse foreman characteristics summarized in Table 10 include averages of tenure, training period, hours worked per week and workers per foreman.

The span of control generally appears to be larger (i.e., more workers per foreman) in the less cost efficient operations. However, the ratio of labor to management does not indicate management 'quality' which may be more important than quantity.

Comparable operations appear in order of increasing potential cost savings from Table 1.

Table 10. Warehouse Management Characteristics
Selected Averages

ID 1/	Years with Firm	Training Period (months)	Hours Worked per Week	Workers per Foreman
08	12	1	46	6.2
35	5	1	51	3.7
61	6	3	44	7.4
03	11		45	6.6
24	12	12	52	23.9
58	10		50	10.6
15	5	6	48	10.8
09	4	1	48	6.2
62	13	5	40	5.2
49	6	16	58	19.9
12	5	2	45	7.7
13	10	3	50	14.2
10	11	1	46	8.3
21	6	2	45	6.4
28	8	2	40	15.3
56				10.2
20	12	8	50	10.3
02	13	9	35	17.1
18	7	6	47	7.9
37	7	1	50	9.4
16	6	4	49	11.0
42	5	3	46	9.4
51				8.6
33	8	14	40	12.4
22	14	2	45	11.4
50				9.3
48	3	6	40	12.1
54				8.4
23	12	2	47	8.6
39	19	7	40	10.3
41	11	0	45	7.4
63	11	3	50	13.1
59	4	3	44	18.1
25	7	58	45	16.7
40	4	0	40	36.0
60	11	26	45	12.0
55				11.9
29		1	40	10.7
57	9	2	45	14.1
Mean	9	7	46	11.5
Min.	3	0	35	3.7
Max.	19	58	52	36.0
		Noncomparable Operations		
43	2	6	45	13.3
44	3		45	8.5
45				11.9
46	10		45	9.6
47	5	4	45	9.7
52				11.2
53				9.2

1/ Ranked in order of increasing potential savings.

Table 11 contains additional data on warehouse supervisors including employment turnover, management productivity incentives, shift worked, hiring source and the ratio of supervisors' pay to workers'.

Annual turnover is measured as the number of managers leaving the organization relative to the usual number employed. Surprisingly, (at least to the authors) more cost efficient operations seem to lose more managers, particularly as a result of termination.

Productivity incentives for supervisors are found more frequently in efficient warehouses than in those which have lower productivity.

Higher proportions of managers working the day shift are associated with greater cost efficiency, a phenomenon which may be related to the higher productivity of the single shift (often daytime) operations observed in storing (Table 6, p. 16), replenishment and order selection (Table 7, p. 18), and shipping (Table 8, p. 20).

Where managers come from (source) and supervisor/worker wage disparity do not exhibit any apparent independent relationship to efficiency.

Comparable operations appear in order of increasing potential cost savings from Table 1.

Table 11. Warehouse Management Characteristics

ID 1/	Annual Turnover (%) Voluntary	Annual Turnover (%) Termination	Incentives	Percent Working Day Shift	Source (%) Firm	Source (%) Outside	Percent Supervisor's Pay/ Worker's Pay
08		25		100	80	20	82
35				55	80	20	75
61			yes	62	100	0	105
03				100	100	0	126
24	33			33	100	0	138
58	10			100	75	25	91
15		38		43	71	29	107
09		25	yes	100	75	25	139
62				100	100	0	126
49		18	yes	56	67	33	101
12				70	10	90	99
13				50	100	0	99
10	5	15	yes	28	67	33	78
21		20		100	80	20	120
28				33	100	0	160
56	NA	NA		NA	NA	NA	96
20	11			89	89	11	96
02	50			100	50	50	105
18	11			56	89	11	124
37				90	20	80	95
16	17			100	83	17	78
42	6	6	NA	NA	94	6	126
51	NA	NA		NA	NA	NA	97
33	11			50	50	50	156
22				100	100	0	124
50	NA	NA		NA	NA	NA	96
48				43	88	12	163
54	NA	NA		NA	NA	NA	99
23				73	91	9	129
39				83	83	17	80
41			yes	67	100	0	131
63				67	67	33	75
59				70	100	0	211
25	NA	NA	NA	70	100	0	150
40				30	100	0	84
60		15		NA	50	50	109
55	NA	NA		NA	NA	NA	101
29				86	86	14	85
57		11	yes	44	78	22	149
Mean				70	81	19	113
Min.				28	10	0	75
Max.				100	100	90	211
			Noncomparable Operations				
43			yes	0	100	0	128
44			yes	NA	100	0	141
45	10			NA	NA	NA	137
46			yes	NA	75	25	130
47	3	1	yes	NA	94	6	131
52	NA	NA		NA	NA	NA	97
53	NA	NA		NA	NA	NA	98

1/ Ranked in order of increasing potential savings.

Table 12 is a brief summary of the work force employed in each of the participating warehouses. Included are data on average worker age, employee turnover and overtime policy.

Comparable operations appear in order of increasing potential cost savings from Table 1.

Table 12. Work Force Characteristics

ID 1/	Average Worker Age	Annual Turnover (%)		Overtime/ Straight Time Percent
		Voluntary	Termination	
08	42	4	0	8.0
35	26	8	10	3.6
61	37	1	2	3.5
03	42	3	8	3.5
24	32	15	4	5.3
58	40	2	1	13.2
15	36	3	2	13.6
09	30	54	14	3.1
62	40	9	0	3.8
49	40	5	1	6.0
12	41	1	1	11.9
13	52	10	0	14.9
10	NA	6	1	3.7
21	48	0	0	3.1
28	42	1	1	10.0
56	NA	NA	NA	8.1
20	51	4	6	11.7
02	46	0	0	5.1
18	43	4	0	4.8
37	42	4	9	11.4
16	48	6	0	11.6
42	31	26	5	11.3
51	NA	NA	NA	8.4
33	40	14	10	7.4
22	57	2	2	6.7
50	NA	NA	NA	7.0
48	35	3	1	5.1
54	NA	NA	NA	6.8
23	43	5	0	6.0
39	46	2	0	3.5
41	34	8	4	5.3
63	34	0	0	NA
59	33	NA	NA	11.0
25	36	17	21	27.3
40	34	15	1	8.4
60	39	1	1	4.4
55	NA	NA	NA	12.4
29	38	8	3	7.4
57	35	6	1	1.4
Mean	40	8	3	7.9
Min.	26	0	0	1.4
Max.	57	54	21	27.3
		Noncomparable Operations		
43	28	1	0	28.4
44	24	25	5	12.5
45	30	5	2	7.1
46	NA	6	0	5.6
47	29	22	13	13.0
52	NA	NA	NA	5.4
53	NA	NA	NA	5.2

1/ Ranked in order of increasing potential savings.

Worker incentive programs and labor productivity standards are the topics addressed by Table 13.

Labor intensive order selection remains the area in which production standards and to a lesser extent productivity incentive programs have been most frequently instituted. The presence of formal standards is somewhat more predominant in more efficient distribution centers than in those with greater potential for savings. However, contrary to expectations, incentive programs are more prevalent in less efficient operations. This could be a result of implementation of incentive programs as a remedy where productivity problems are perceived to be and probably are very serious.

Comparable operations appear in order of increasing potential cost savings from Table 1.

Table 13. Labor Relations - Incentives and Standards

ID [1]	Incentives [2]					Standards [4]				
	TR	RR	SR	OS	SH [3]	TR	RR	SR	OS	SH
08									IE	
35				$T					IE	IE
61						PS	PS	PS	IE	PS
03						IE	IE	PS	IE	PS
24						IE	IE	IE	IE	IE
58									IE	
15									PS	
09				$		PS	PS	PS	PS	PS
62									PS	PS
49									IE	
12										
13						IE	IE	IE	IE	
10						IE	IE	IE	IE	IE
21							PS		IE	
28						IE	IE		IE	IE
56										
20						IE			IE	IE
02						PS	PS	PS	IE	PS
18									IE	
37						PS	IE	PS	IE	IE
16						PS	PS	PS	IE	PS
42				$		PS	PS	PS	PS	PS
51										
33				$		PS	PS		PS	
22							PS		IE	
50										
48										
54										
23									IE	
39									IE	
41				$				PS	PS	
63						IE	IE	IE	IE	IE
59				$					IE	
25				$T			IE	IE	IE	
40				$T					IE	
60										
55										
29									IE	
57	T	T	T	T	T				PS	PS
					Noncomparable Operations					
43						PS		PS	PS	
44								PS		
45							PS	PS	PS	PS
46									PS	PS
47				$		PS	PS	PS	PS	PS
52										
53										

1/ Ranked in order of increasing potential savings.

2/ $ - money
T - time off
O - other

3/ TR - truck receiving
RR - rail receiving
SR - storage and replenishment
OS - order selection
SH - shipping preparation

4/ PS - indicates productivity standards in use
IE - indicates standards based on industrial engineering study

Table 14 contains labor relations data relating to job assignments, overtime work, absence and job classifications.

It is interesting to note the number of 'NA' responses to the question regarding absent hours, especially by those operations which adhere to a formal absence policy. Evaluation of an absence policy's effectiveness would seem to be rather difficult without an accurate measure of the problem's severity.

Comparable operations appear in order of increasing potential cost savings from Table 1.

Table 14. Labor Relations - Job Assignments, Overtime, Absence and Classifications

ID 1/	Jobs Assigned by Seniority 2/	Overtime Mandatory 3/	Absence Percent	Absence Policy	Number of Job Classifications
08			1.2	Yes	5
35			2.0	Yes	7
61			3.9	Yes	2
03			3.5	Yes	11
24			2.0	Yes	17
58		No	NA	Yes	15
15			3.1	Yes	11
09	No		NA	Yes	6
62			4.3	Yes	8
49			7.8	Yes	3
12		No	NA		5
13			4.9		7
10			NA	Yes	12
21			NA		6
28		No	5.6	Yes	14
56		No	NA		NA
20			NA	Yes	8
02			0.4		5
18		No	7.9		15
37			6.8	Yes	10
16			NA	Yes	2
42	No		2.5	Yes	7
51		No	NA		NA
33		No	0.2		3
22			NA		5
50		No	NA		NA
48			5.0		5
54			NA		NA
23			4.5	Yes	10
39			4.6		19
41			0.8	Yes	7
63			4.7	Yes	17
59	No		NA	Yes	5
25			2.0	Yes	6
35			8.4	Yes	6
60		No	NA	Yes	12
55			NA	Yes	NA
29			NA		NA
57		No	5.2	Yes	24
Mean			4.0		9
Min.			0.2		2
Max.			8.4		24
		Noncomparable Operations			
43	No		1.5	Yes	10
44			0.4	Yes	7
45			NA	Yes	7
46	No		NA	Yes	7
47			1.9	Yes	10
52		No	NA		NA
53		No	NA		NA

1/ Ranked in order of increasing potential savings.

2/ Job assignment is by seniority unless otherwise noted.

3/ Overtime work is mandatory unless otherwise noted.

Unionization and its characteristics are the focus of Table 15. Specifically listed are an indication of union or nonunion status, years since organization for unionized operations, degree of labor unrest reflected in the frequency of strikes and the presence of productivity standards and absence policies in union contracts.

Unionization by itself appears to be predominantly associated with more efficient warehouses. However, the small number of nonunion operations in this sample probably does not provide conclusive evidence relative to the effect of unions on efficiency.

Comparable operations appear in order of increasing potential cost savings from Table 1.

Table 15. Labor Relations - Unionization, Strikes and Contract Provisions

ID [1]	Unionized [2]	Years Organized	Strikes in Last 20 Years	Written into Union Contract [3] Standards	Absence Policy
08		35	0		Yes
35	No				
61		41	7		
03		40	1		
24		18	0		
58		18	1		
15		23	3		
09	No				
62		35	1	Yes	Yes
49		45	1		
12		15	0		
13		29	0		
10		21	10	Yes	Yes
21		23	0		
28		15	0		
56		NA	NA		Yes
20		NA	3		
02		NA	1		
18		11	4		
37		NA	NA		
16		30	1		Yes
42	No				
51		NA	NA		
33	No				
22		23	2		
50		NA	NA		
48		36	0		
54		NA	NA		
23		52	1		
39		35	0		
41	No				
63		25	6		
59	No				
25		32	4		
40		20	2		
60		NA	0		
55		NA	NA		Yes
29		NA	0		
57		27	4		
Mean		28	2		
Min.		11	0		
Max.		52	10		
		Noncomparable Operations			
43	No				
44	No				
45	No				
46	No				
47	No				
52		NA	NA		Yes
53		NA	NA		Yes

1/ Ranked in order of increasing potential savings.

2/ Unionized unless otherwise noted.

3/ Standards and absence policy are not in the contract unless otherwise specified.

Table 16 indicates the absence of certain provisions (i.e., overtime assignment, job assignments, job classifications and grievance procedure) from the union contract.

Comparable operations appear in order of increasing potential cost savings from Table 1.

Table 16. Labor Relations - Contract Provisions

ID[1/]	Provisions Written into Union Contract[2/]			
	Overtime Assignment	Job Assignments	Job Classifications	Grievance Procedure
08				
35				
61				
03				
24	No	No		No
58			No	
15				
09				
62				
49	No	No		
12	No			
13				
10				
21				
28				
56				
20	No	No	No	
02				
18				
37				
16				
42				
51			No	
33				
22				
50			No	
48				
54	No	No		
23				
39				
41				
63				
59				
25	No			
40	No	No		
60				
55				
29	No			
57				
	Noncomparable Operations			
43				
44				
45				
46				
47				
52		No	No	
53		No	No	

1/ Ranked in order of increasing potential savings.

2/ Overtime assignment, job assignments, job classifications and grievance porcedure are in the contract unless otherwise noted.